

What is claimed is:

1 1. A method for forming an interconnect structure
2 with dielectric barrier, comprising the steps of:

3 providing a semiconductor substrate with a first
4 dielectric layer formed thereon, wherein a
5 plurality of conductive lines are formed with
6 a conductive plug thereon in the first
7 dielectric layer;

8 removing the first dielectric layer to leave a
9 plurality of stacked structures formed by the
10 conductive line and the conductive plug
11 thereon;

12 forming a conformal dielectric barrier on surfaces
13 of the stacked structures; and

14 blanketly forming a second dielectric layer over
15 the dielectric barrier to form an inter-metal
16 dielectric (IMD) layer for insulating the
17 stacked structures.

1 2. The method as claimed in claim 1, wherein the
2 etching stop layer comprises oxygen-containing material.

1 3. The method as claimed in claim 2, wherein the
2 oxygen-containing material is silicon oxycarbide (SiCO).

1 4. The method as claimed in claim 1, wherein the
2 first dielectric layer comprises a plurality of oxygen-
3 free dielectric layers.

1 5. The method as claimed in claim 4, wherein the
2 oxygen-free material comprises pure silicon carbide, P-
3 SiLK or other porous low-k dielectric.

1 6. The method as claimed in claim 1, wherein the
2 conductive line comprises copper or copper aluminum
3 alloy.

1 7. The method as claimed in claim 1, wherein the
2 conductive plug comprises copper or copper aluminum
3 alloy.

1 8. The method as claimed in claim 1, wherein the
2 dielectric barrier comprises silicon oxycarbide (SiCO) or
3 silicon carbonitride (SiCN) with a dielectric constant of
4 4.5-5.0.

1 9. The method as claimed in claim 1, wherein the
2 second dielectric layer comprises carbon-incorporated
3 silicon oxide (SiOC) with a dielectric constant of 2.5-
4 3.0.

1 10. A method for forming a interconnect structure
2 with dielectric barrier, comprising the steps of:

3 providing a semiconductor substrate with an oxygen-
4 containing etching stop layer and a oxygen-
5 free first dielectric layer sequentially
6 formed thereon, wherein a plurality of
7 conductive lines are formed with a conductive
8 plug thereon in the first dielectric layer;

9 removing the oxygen-containing first dielectric
10 layer by etchant comprising N₂ and H₂ to leave
11 a plurality of stacked structures formed by

the conductive lines and each conductive plug
thereon;

depositing a conformal dielectric barrier on
surfaces of the stacked structures; and
blanketly forming a second dielectric layer with at
least one air gap over the dielectric barrier
to form an inter-metal dielectric (IMD) layer
for insulating the stacked structures.

11. The method as claimed in claim 10, wherein the
oxygen-containing etching stop layer comprises silicon
oxycarbide (SiCO) or silicon carbonitride (SiCN) with a
dielectric constant of 4.5-5.0.

12. The method as claimed in claim 10, wherein the
oxygen-free first dielectric layer comprises a plurality
of oxygen-free dielectric layers.

13. The method as claimed in claim 12, wherein the
oxygen-free dielectric layers comprise pure silicon
carbide, P-SiLK or other porous low-k dielectric.

1 14. The method as claimed in claim 10, wherein the
2 conductive line comprises copper or copper aluminum
3 alloy.

1 15. The method as claimed in claim 10, wherein the
2 conductive plug comprises copper or copper aluminum
3 alloy.

1 16. The method as claimed in claim 10, wherein the
2 dielectric barrier comprises silicon oxycarbide (SiCO) or
3 silicon carbonitride (SiCN) with a dielectric constant of
4 4.5-5.0.

1 17. The method as claimed in claim 10, wherein the
2 second dielectric layer comprises carbon-incorporating
3 silicon oxide (SiOC) with a dielectric constant of 2.5-
4 3.0.

1 18. An interconnect structure with dielectric
2 barrier, comprising:

3 a semiconductor substrate;

4 a plurality of stacked structures formed thereon,
5 wherein each stacked structure comprises a
6 conductive line and a conductive plug thereon;
7 a conformal dielectric barrier over the surfaces of
8 the stacked structures; and
9 a blanket second dielectric layer formed over the
10 dielectric barrier to form an inter-metal layer
11 for insulation thereof.

1 19. The interconnect structure as claimed in claim
2 18, further comprising an etching stop layer disposed
3 between the semiconductor substrate and the dielectric
4 barrier.

1 20. The interconnect structure as claimed in claim
2 18, wherein the etching stop layer comprises oxygen-
3 containing material.

1 21. The interconnect structure as claimed in claim
2 20, wherein the oxygen-containing material comprises
3 silicon oxycarbide (SiCO) or silicon carbonitride (SiCN).

1 22. The interconnect structure as claimed in claim
2 18, wherein the first dielectric layer comprises a
3 plurality of oxygen-free dielectric layers.

1 23. The interconnect structure as claimed in claim
2 22, wherein the oxygen-free dielectric layers comprise
3 silicon carbide, P-SiLK or other porous low-k dielectric.

1 24. The interconnect structure as claimed in claim
2 18, wherein the conductive line comprises copper or
3 copper aluminum alloy.

1 25. The interconnect structure as claimed in claim
2 18, wherein the conductive plug comprises copper or
3 copper aluminum alloy.

1 26. The interconnect structure as claimed in claim
2 18, wherein the dielectric barrier comprises silicon
3 oxycarbide (SiCO) or silicon carbonitride (SiCN) with a
4 dielectric constant of 4.5-5.0.

1 27. The interconnect structure as claimed in claim
2 18, wherein the second dielectric layer comprises carbon-

3 incorporated silicon oxide (SiOC) with a dielectric
4 constant of 2.5-3.0.

1 28. The interconnect structure as claimed in claim
2 18, further comprising at least one air-gap in the second
3 dielectric layer between the stacked structures.

1 29. An interconnect structure with dielectric
2 barrier, comprising:

3 a semiconductor substrate;

4 a pair of stacked structures formed thereon, wherein

5 each stacked structure comprises a conductive

6 line and a conductive plug thereon; and

7 a conformal dielectric barrier disposed along

8 sidewalls of each stacked structure.

1 30. The interconnect structure as claimed in claim
2 29, further comprising a blanket second dielectric layer
3 formed on the dielectric barrier to form an inter-metal
4 layer.

1 31. The interconnect structure as claimed in claim
2 29, wherein the dielectric barrier is disposed along the
3 substrate between the stacked structures.

1 32. The interconnect structure as claimed in claim
2 29, further comprising an etching stop layer disposed
3 between the semiconductor substrate and the dielectric
4 barrier.

1 33. The interconnect structure as claimed in claim
2 32, wherein the etching stop layer comprises oxygen-
3 containing material.

1 34. The interconnect structure as claimed in claim
2 33, wherein the oxygen-containing material comprises
3 silicon oxycarbide (SiCO) or silicon carbonitride (SiCN).

1 35. The interconnect structure as claimed in claim
2 29, wherein the first dielectric layer comprises a
3 plurality of oxygen-free dielectric layers.

1 36. The interconnect structure as claimed in claim
2 35, wherein the oxygen-free dielectric layers comprise
3 silicon carbide, P-SiLK or other porous low-k dielectric.

1 37. The interconnect structure as claimed in claim
2 29, wherein the conductive line comprises copper or
3 copper aluminum alloy.

1 38. The interconnect structure as claimed in claim
2 29, wherein the conductive plug comprises copper or
3 copper aluminum alloy.

1 39. The interconnect structure as claimed in claim
2 29, wherein the dielectric barrier comprises silicon
3 oxycarbide (SiCO) or silicon carbonitride (SiCN) with a
4 dielectric constant of 4.5-5.0.

1 40. The interconnect structure as claimed in claim
2 30, wherein the second dielectric layer comprises carbon-
3 incorporated silicon oxide (SiOC) with a dielectric
4 constant of 2.5-3.0.

1 41. The interconnect structure as claimed in claim
2 30, further comprising at least one airgap in the second
3 dielectric layer between the stacked structures.